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Research Article

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Numerical simulation and optimization of dense phase tower entrances

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ABSTRACT

This paper uses the Fluent software to dense flow absorber simulation, studied the influence of entrance on the flue gas flow field pressure and turbulence intensity and system pressure loss. Research shows that: in the simulated conditions optimal layout for the B entrance, the entrance of B loss of the pressure when gas flow is 32Pa, than the entrance way a low around 30%; entrance way B more conducive to inhibit the flue gas back mixing phenomenon.

Key words: Dense flow absorber; Desulphurization; Numerical simulation; Flow field; Turbulence; Pressure loss

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INTRODUCTION

Flue gas desulfurization technology of dense phase Tower is a typical line of gas-solid flow and bed semi-dry flue gas desulfurization reactor. The desulphurization process is absorbed by the Beijing science and Technology University in Germany FHW combustion flue gas desulfurization technologies on the basis of, according to China's actual conditions and development of semidry flue gas desulfurization technology of an advanced[1]. Dense phase Tower FGD technology suitable for small and medium sized coal-fired power plants, steel plants sintering machine flue gas desulfurization project of flue gas and waste incinerators. Dense tower flue gas desulphurization technology belongs to a class of semi dry desulfurization process for humidifying. The basic principle of this process is the use of dry powder of calcium based sorbents (common lime) for humidification in the humidifier, into the dense phase tower and tower descending flue gas containing SO_2 mixing and reaction[2].

Dense tower flue gas desulfurization absorption tower and common process equipment, has its own characteristics, such as equipment of large scale, wide load range, high impurity content, high anti-corrosion requirements[3]. The chemical process amplification device design, is a new challenge. Results some qualitative tower equipment design can only be given by traditional method, the routine method of test, in the device has been put into operation on the real test are not realistic, so the computer aided design technology to replace most of the research in the experimental work is necessary[4]. With the development of modern mechanics and computer hardware and software technology, makes it is possible to simulate a full size on the absorption tower. Computational fluid dynamics numerical simulation tools will help to understand the fluid flow, heat transfer and absorption tower in the chemical reaction process, the analysis results give a series of qualitative and quantitative, thus optimizing design method of flue gas desulfurization absorption tower, which lays a theoretical foundation for the flue gas desulfurization project of domestic[5]. At the same time to reduce the technology development costs, master and developing new desulfurization technology is very good, also has the important meaning to the safe and stable operation of flue gas desulfurization system in the future.

Rules and characteristics of the numerical simulation method can better reflect the dense phase gas-solid two-phase flow and tower desulfurization reaction, the result error and test results in an acceptable range, has a good reliability. Methods for design and optimization of dense phase reactor structure by numerical simulation is feasible[6]. In this paper, using Fluent software simulation of the effects of dense flow absorber entrance on the turbulence intensity of flue gas flow field and the reaction zone, explore and seek a reasonable working condition, provide a reference for practical engineering.

1. The research contents and methods

The uniformity of the dense phase gas flow determines the desulfurization efficiency of desulfurization tower, the tower entrance mode determines the distribution of dense phase dense tower flue gas, but also directly affects the system pressure drop. The design principle of dense phase tower entrance way with:

(1) In the entrance flue to install flue damper, as far as possible with square flue;
(2) Sintering flue gas dust in high density, flue gas velocity is considered slightly higher than standard value;
(3) Entrance pressure loss;
(4) Entrance flue regular shape, easy to install flow, temperature detection equipment;
(5) Entrance to the gas distribution optimization.

Considering the above design principles, this paper designs 3.2 x 3.2m the entrance flue, flue gas flow rate of 17.5m/s. Adopt two kinds of methods in the process of simulation entrance flue: A for the square pipe through the form, the geometric size of the visible in Table 2.1 and figure 2.1; B square tube tract gradually expanding access mode, the geometric size of the visible Table 2.1 and figure 2.2.

Table 2.1 dense tower entrance optimization parameter table

PARAMETERS		COMPANY	NUMERICAL	REMARKS
ENTRANCE FLUE GAS FLOWQ		M^3/S	180	
THE FLUE GAS TEMPERATET		℃	120	
ENTRANCE FLUE GAS DENSITYP		KG/M^3	0.85	
THE DESIGN OF ENTRANCE FLUE GAS VELOCITY VIN		M/S	12～18	
THE PIPELINE SECTION AREA ENTRANCE		M^2	17.5	
ENTRANCE WAYA（TUBE STRAIGHT）				
PIPELINE SECTION SIZE		M	3.2	FIGURE 1-1
ENTRANCE WAYB（GRADUALLY EXPANDING PIPE）				
SQUARE TUBE SECTION SIZE		M	3.2	FIGURE 1-2
FLARING SEGMENT SIZE	LONG	M	4	
	EXPANDING ANGLE	°	10	

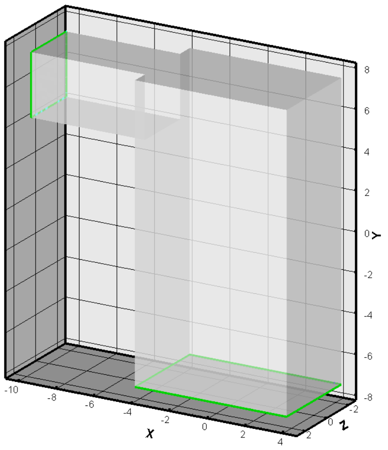

Figure2.1Dense tower entrance way A

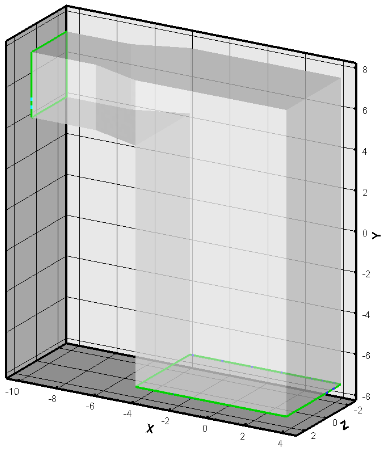

Figure 2.2 Dense tower entrance way B

Figure 2.3 and Figure 2.4 are pressure gradient map entrance sections A and B entrance way, between each section of the pressure difference are the same. From figure 2.3 we can see between the pressure section entrance in A stack is dense, the pressure in the leeward area of vortex connection through the entrance pipeline and the dense phase tower form two near wall low pressure core[7] the entrance region of the pressure drop is about 45Pa. From Figure 2.4 we can see between the entrance in B stack pressure section is sparse, pressure vortex in straight entrance pipeline and gradually expanding pipe joint also formed two near wall is low key, but the two pressure vortex strength was significantly lower than A in the vortex intensity, the whole entrance region pressure drop is about 32Pa, A than the entrance pressure drop to about 30%.

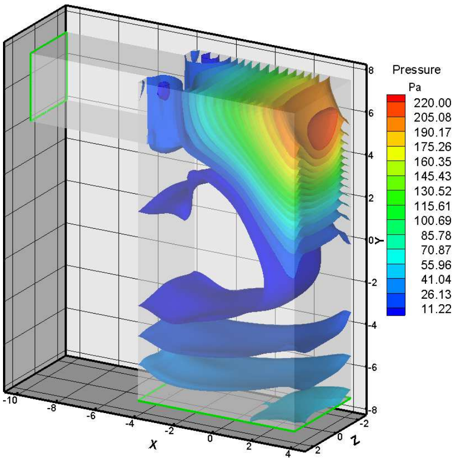

Figure 2.3Entrance way A Section of Pressure

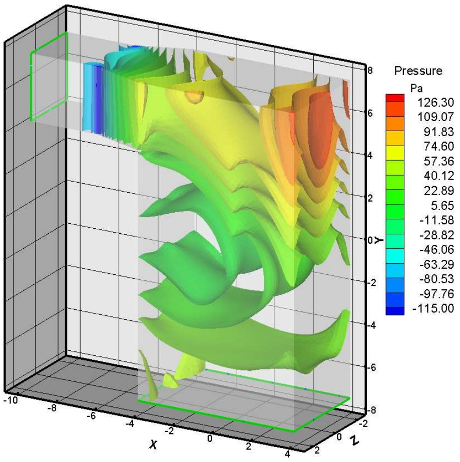

Figure 2.4Entrance way B Section of Pressure

Figure 2.5 and Figure 2.6 are respectively Z=0 section, different height (different Y values) of flue gas velocity diagram, the horizontal axis is the direction of X distance, Y axis for the velocity of flue gas, flue gas velocity in the Y direction is the direction of. The curve in Figure two we can see the entrance way, A and B have different degree of gas backmixing[8], the different height of the tower body of the flue gas velocity is very uneven, but the entrance flue gas flue gas A backmixing of entrance way than B generated backmixing phenomenon to be serious, flue gas the interior of the tower body flow formed by the entrance way of B than the entrance way A formed by the interior of the tower body to uniform velocity of flue gas. From the flue gas flow and mixing weakened, entrance mode of B is much better than the entrance of A.

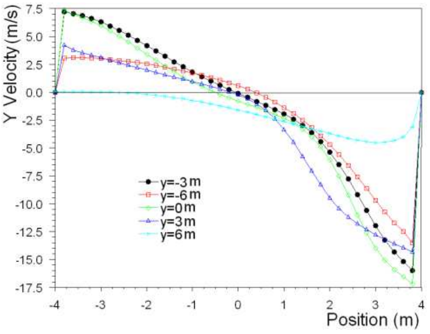

Figure 2.5Entrance way A Different height velocity

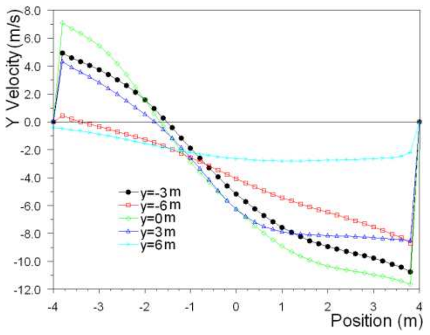

Figure 2.6Entrance way A Different height velocity

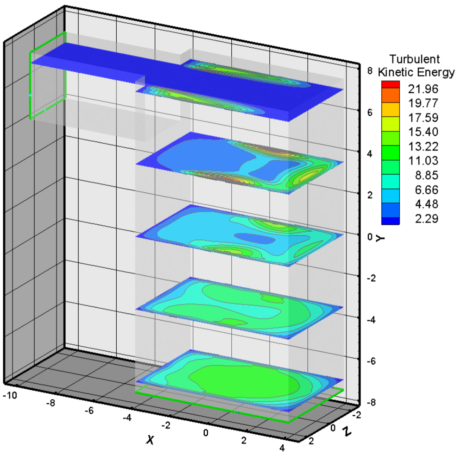

Figure2.7Entrance way A The turbulent kinetic energy gradient

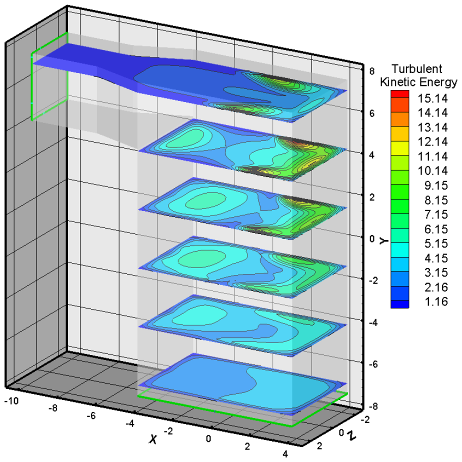

Figure 2.8Entrance way B The turbulent kinetic energy gradient

Figure 2.7 and figure 2.8 for the different entrance way in the turbulent kinetic energy gradient maps of different Y section, we can see from figure 2.7, entrance mode A turbulent kinetic energy larger areas are concentrated near the tower wall, forming two narrow high turbulence kinetic energy region in the tower at the entrance, while the high turbulent kinetic energy area the reaction zone of the tower body is made by the two regional development, but because the region closer to the tower wall, the turbulent kinetic energy dissipation and fast region[9]; we can see from Fig. 2.8, entrance mode B in the entrance tower also formed two larger turbulent kinetic energy region, but its position than the entrance way A closer to the flue gas flow downstream, and because of its being the tower shell wall constraint gradually from the tower wall to form a triangular area, high turbulent kinetic energy region by the development of effective reaction region to gradually extend to the lower part of the tower body[10], but because of the region from the tower wall is relatively far and near, the turbulent kinetic energy dissipation than the entrance region of high turbulence kinetic energy region of the form A to slow.

CONCLUSION

Thus, the entrance of B loss of the pressure when the smoke flow than the entrance way A low around 30%; entrance way B can restrain the flue gas back mixing phenomenon. Changing the entrance way can effectively change the dense smoke tower flow, and inhibit the backmixing phenomena flue gas entrance way, B is superior to An entrance, the entrance of B in the actual project application way.

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